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MEMORANDUM FOR: [redacted]
CIEP
The White House

Here is the final version of the joint OER-OSI contribution to your chapter on technology transfer. I hope you will find it of some help.

[redacted]
Acting Deputy Chief
USSR/Eastern Europe Division

STAT

12 Nov 1973
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STAT

TRANSFER OF TECHNOLOGY FROM THE US TO THE USSR

PROBLEMS AND PROSPECTS

12 November 1973

I. Background of the Soviet Interest in US Technology

Since 1960 Soviet economic growth has slowed appreciably despite large continuing increases in the labor force and investment. For a number of reasons, the annual rate of increase of the productivity of labor and capital inputs fell off abruptly in the 1960s, and productivity actually declined in 1971-72.

Average Annual Rate of Growth
(Percent)

	1951-60	1961-70	1971-72
GNP	6 1/2	5 1/2	3
Output per unit of labor and capital	3	1 1/2	-1

Looking into the future, Soviet leaders recognized that economic growth would not turn upward again unless productivity could be accelerated. Because of lower birth rates, the labor force would eventually increase at a slower rate while the growth of plant and equipment is becoming harder to sustain in the face of competing demands for consumer goods.

In part, the disappointing performance of productivity since 1960 has been caused by a failure to introduce improvements in technology at the rate that was possible during the period of reconstruction after World War II. The lower

rate of Soviet technological advance, moreover, has preserved the substantial technological gap that separates Western from Soviet practice in almost every economic sector.

This disparity in technology is of great concern to the leadership, particularly since the resources devoted to promoting technological progress are enormous. The USSR has more engineers employed in RDT&E* than the US and almost as many scientists. Expenditures on R&D are now almost four times the 1960 level while the number of scientific workers with advanced degrees increased from 109 thousand in 1960 to 298 thousand in 1972. A major problem is that the R&D sector has been characterized by great uneveness. Basic research, particularly theoretical work, is considered strong while applied R&D has been weak except perhaps in priority military sectors and the space program, which attract the best scientific and material assets. In large part, the weakness of applied R&D in the civilian economy stems from its incompatibility with rigidly-centralized direction and management. In addition, the indifferent quality of many Soviet engineers and applied scientists has hampered the civilian R&D effort. The training of Soviet engineers and applied scientists is rather narrow, and many of the engineers are best described as technicians by Western standards.

*Research, development, testing, and evaluation -- the span of the innovation process from basic research to introduction into series production. This entire process will be referred to as R&D in this paper.

In the 1960s the Soviet leaders first concentrated on domestic reform as the solution for sagging economic performance. The 1965 reform of economic administration and numerous decrees designed to reform applied R&D were intended to spur productivity growth. Reform has not produced the desired results, however, and the USSR has turned increasingly to imported technology as a means of accelerating technical progress and economic growth. The recent US-Soviet detente has encouraged this trend. A relaxation of US export controls and the offer of US credits have spurred Soviet acquisitions of equipment and technology from the US, although West Germany and Japan are still the largest free world suppliers of machinery and equipment to the USSR.

The revival of Soviet interest in US products and technology is partly political but is also in line with the traditional policy of acquiring the most-advanced technology available. US companies are the preferred sources of automotive equipment, oilfield equipment, computer hardware, and civilian aircraft technology. The Soviets are also seeking equipment and knowhow from the US in numerous more specialized areas such as cryogenics, air traffic control, and advanced metallurgical processing. If contracts cannot be reached with US companies, the Soviets recognize that other countries often can provide technology that is as good or almost as good. The USSR has had success, for example, in buying

computer hardware and some kinds of automotive equipment and machine tools from Western Europe and Japan. In other areas, such as oilfield equipment for Arctic exploration, the US is the only technology source in the eyes of the Soviets

II. Soviet Acquisition of Foreign Technology

Overview

The USSR has acquired foreign technology mainly by purchasing machinery and equipment. Machinery imports, which still constitute the most important means of technology transfer, are increasing rapidly. Other channels of transfer have included the acquisition of technical data (by purchase or theft), visits with Western firms, and formal agreements for collaborative research and the exchange of scientific and technical information.

Since foreign machinery and equipment account for only a small part of total investment, and since the exploitation of technical information represents only a stage in the total R&D process, the ultimate impact of such acquisitions has depended on the USSR's ability to duplicate and adapt the technology embodied in the equipment or represented in the technical data. Soviet engineers have had mixed success in exploiting foreign technical data or in practicing "reverse engineering" on examples of Western machinery. In the military area, their performance has been sometimes startling as in the quick duplication and production of Western air defense missiles. In other areas the Soviet applied R&D sector has been so slow in working with Western blueprints or models that the products are obsolete by the time they

enter series production. The Soviet effort to copy US space suit technology, for example, resulted in a product 7-8 years behind the current US level of sophistication. Copies of US biological materials (vaccines, antibiotics) are not up to US standards of efficacy and purity. In what has been a classic example of reverse engineering, the Soviet attempt to copy IBM machines with the RYAD family of computers is far behind schedule.

To bypass some of these problems of exploiting foreign technology, the USSR has recently placed greater emphasis on buying turnkey plants and arranging cooperative ventures with Western firms. Although expensive, turnkey plants avoid many of the problems that plague the Soviet applied R&D sector. Soviet-style cooperative ventures permit the USSR to acquire technology in exchange for the products (manufactured goods or raw materials) of the venture. They ensure Western participation in the development through the design and pilot plant stage and beyond and provide for reversion of full rights to production to the USSR at the end of a stated term. By that time, the debt owed to Western firms is to be repaid; hence, the projects are designed to be self-liquidating.

Obstacles to Acquisition of Foreign Technology

The prime source of foreign technology for the USSR -- machinery imports -- has its limits. Although the USSR has expanded its imports from the West, it has been unable to generate a reciprocal expansion of exports. The resulting shortage of hard currency has been the most important constraint on Soviet acquisition of Western equipment and technology. The increased availability of Western medium- and long-term credits has eased this constraint somewhat; between 1969 and 1972, the USSR drew more than $3 billion in medium and long-term Western credits to finance imports of advanced Western machinery, equipment and technology.

During the period when the volume of Western credits grew, the lack of US credits diluted Soviet interest in US equipment and technology. But since the May 1972 summit this barrier has been partly dismantled. The importance of some other factors that have impeded the flow of US equipment and technology to the USSR in the past has also diminished with the onset of detente; the effect of others remains unchanged. The current status of these obstacles to technology transfer is discussed below:

US attitudes toward trading with the USSR have long obstructed transfers of US technology to the USSR. Many US firms have opposed trading with the USSR, and US public

opinion has influenced other firms to refuse to deal with the USSR. Since the mid-1960s, these attitudes have shifted a great deal in favor of increased contacts with the Soviet Union.

- Bureaucratic problems unique to the conduct of trade with the Soviet Union present special problems for US businessmen. Long, expensive pilgrimages to Moscow without assurance of seeing the right people are often followed by long, difficult, and expensive negotiations with the Soviets that do not bear fruit. The US businessman is frustrated by the great difficulty in contacting the ultimate user of his product; he must work with foreign trade organizations instead, adding to the usual delays encountered in conducting business in the USSR.

- Western firms are frequently reluctant to part with their technology, preferring the sale of their finished products to a transfer that might generate future competition for the firms in world markets.

- Export controls continue to limit Soviet access to very specialized and sophisticated foreign technology. The range of controls has been reduced substantially in recent years, however, as East-West tensions have eased and as Western exporters have pressed for expanded sales to Communist countries. The US is now supplying the Kama River

truck complex with manufacturing equipment and technology that was embargoed two years ago. Computers, integrated circuits, telecommunications, avionics and other sophisticated electronics technology continue to be controlled, although controls have been relaxed even in these fields. Third generation computers of rather sophisticated design can now be exported where they could not be a year ago. Nevertheless, the controls on other high-technology items such as advanced disc units and disc pack technology still hinder Soviet computer development.

Problems in Assimilating Foreign Technology

Foreign technology has been of less help to the Soviet Union than expected in a great many instances. One major reason has been the failure of purchased machinery to mesh well with existing Soviet equipment, with other foreign equipment, or with Soviet inputs within a production process. In part, this interface problem is a natural one. The Soviet applied R&D sector, however, takes an inordinate length of time to solve problems of compatibility in the civilian economy. For example, in 1968 it was given the job of developing control units for Calcomp plotters that were being purchased from the US. By 1970, sixteen plotters worth over $400,000 had been purchased, but none had been installed because the control units had not been developed.

The USSR's difficulties in assimilating foreign technology stem partly from the Soviet tendency to import technology that is too advanced for rapid exploitation, given existing levels of domestic technological development. This overreaching is especially evident in the computer field but extends into other sectors as well. Some of the equipment being purchased for the Kama truck factory is believed to be overly sophisticated considering the present level of Soviet automotive technology. A US firm negotiating to supply tool-and-die-machines said that Soviet automotive technicians were unaware of advancements after 1962. In negotiations over the Kama paint lines, the Soviets insisted that Soviet chemicals be used even though they were 10 years behind comparable US products and were not suited for use with the US equipment. Accordi to Western observers, Soviet engineers will encounter great difficulty in integrating all of the machinery in the Kama factory since the equipment is being supplied piecemeal by numerous foreign firms.

Assimilation is sometimes more difficult than it otherwise would be because of Soviet reticence in supplying foreign companies with information on how the imported machinery is to be used. Again using the Kama plant as an example, the buildings at the truck plant are standing, and foreign equipment will have to fit into space allotments that have already been designated. Yet foreign suppliers have been hindered in obtaining useful drawings of the factory and in obtaining permission to visit the site. Where security is considered critical, the USSR would rather forego a purchase than release details necessary to make an interface possible. For this reason, purchases of aircraft navigation equipment, radar equipment, and the like have been deferred in the past.

Assimilation of foreign technology also depends on the quality of the labor force. Soviet workers must first master the unfamiliar and complex foreign machinery and for this reason many foreign-built plants do not reach rated capacity until after lengthy delays. As a result, foreign firms often are asked to train the work force as part of the sales agreement. Such training has been hampered by language barriers and frequent conflicts between Soviet workers and foreign supervisors.

To keep foreign plants and equipment operating, the USSR needs a steady supply of spare parts and solid maintenance programs. Shortcomings in these areas have often put foreign equipment out of commission. Foreign-made spare parts seem to be purchased only for high-priority industries such as the chemical industry. Industries with lower priority apparently get no foreign exchange to buy spare parts. Because of the shortage of foreign spare parts, low priority industries may favor less modern domestic machinery or East European machinery even if hard currency is available for the purchase of original equipment from the West.

Because of its problems in assimilating imported technology piecemeal, the USSR, as indicated earlier, has turned increasingly to the purchase of turnkey factories. Foreign firms design the factory, supervise construction, and are responsible for the selection and installation of equipment; Soviet workers assume control once the plant is operating. The USSR has purchased numerous chemical plants on a turnkey basis, but the most famous turnkey plant in the USSR is the Volga motor vehicle plant at Tol'yatti,

purchased from FIAT of Italy. Like many turnkey factories, construction of the Tol'yatti plant took much longer than would be usual in the West. The contract was signed in 1966, but capacity production will not be reached until 1974 or 1975.

Turnkey plants have not proved to be the final answer to the USSR's difficulties with assimilating foreign technology because they are too expensive to buy on a massive scale and because they do not resolve all of the interface problems cited above. Often the Western plants require labor skills in construction and operation that exceed the skills available on site in the Soviet Union. In addition, as the Soviets found in taking over Western-built chemical plants, the processes sometimes demand raw and semi-finished materials of a quality that the domestic economy is not prepared to supply.

It should be noted, too, that Soviet deficiencies in modern industrial management may cause serious problems in digesting large complexes. Many Western plants are designed to be run by managers who are proficient in managing complex technological processes. By contrast, Soviet managers have tended to concentrate on relatively simple production goals. Indeed, one of the main goals of the current campaign to create more production associations is to find a way to make individual production units work effectively in a complex akin to a large US corporation.

III. Recent Soviet Initiatives in Acquiring Foreign Technology

Larger Purchases of Foreign Equipment

The increased Soviet reliance on foreign technology shows most dramatically in the value of imports of Western machinery and equipment, which climbed to a record 1.4 billion in 1972, about $800 million higher than the level in the mid-1960s. The rise demonstrates that despite the problems encountered by the USSR in assimilating foreign technology the Soviet leaders are convinced that machinery purchases are worthwhile.

Indeed the USSR has been forced to turn to the West to meet its changing priorities with respect to domestic programs that simply did not have an adequate internal base. In the early 1960s, for example, chemical plant and equipment loomed large in Soviet imports from the West. These gave way in the middle and late 1960s to imports of automotive equipment for the giant FIAT plant and for the modernization of existing motor vehicle plants. In the past few years, imports of machinery and equipment (including large diameter pipe) for transmitting natural gas have totaled several hundred million dollars. Last year's heavy purchases were concentrated in the automotive, chemical, and wood processing industries. Currently, a large part of machinery imports will be used to satisfy the requirements of the Kama truck complex.

Search for Economic Cooperation

The increased availability of long-term credits on favorable terms enabled the USSR to postpone the consequences of its inability to sell enough to the West. Nevertheless, Soviet indebtedness to the West has increased sharply; by the end of this year it will amount to $3.5 billion, and 27% of the USSR's hard currency exports will be needed just for debt service. As noted in the discussion of the channels of technology transfer, economic cooperation agreements with the West offer a partial solution to the USSR's growing financial problems.

Agreements in the form of cooperative ventures provide for the export to the USSR of equipment and technology on long-term credits. The credits are to be repaid by deliveries of goods produced by the venture, easing the Soviet hard currency problem. Indeed, these projects often involve Soviet deliveries in excess of repayments and thus creat new markets for Soviet exports. The gas-for-pipe deals with West Germany, France, Italy, and Austria are prime examples of this kind of arrangement. More recently, Occidental Petroleum and Texas El Paso signed a letter of intent with the USSR to help develop the Yakutsk natural gas fields in Eastern Siberia and to supply transmission equipment and facilities in exchange for a share of the gas over a given period of years.

Bilateral S&T Cooperation

The trade and joint venture aspects of the transfer of technology between the US and the USSR basically favor the USSR and are of a conventional commercial nature. Since the US-USSR summit meeting of May 1972, the Soviet Union has also strongly supported increased cooperative research with the US in scientific and technological areas. The Soviets portray S&T cooperation as a means of achieving a genuine exchange of technology and enhancing the returns to the vast resources devoted to research and development in the two countries.

Under the US-USSR Agreement on Cooperation in the Fields of Science and Technology signed on May 24, 1972, the Soviet have participated actively in planning joint research programs with US scientists in a variety of fields including medicine and biology, space chemical catalysis, energy research, microbiological synthesis, and scientific and technical information processing. They have also markedly increased the number of direct contacts with US industrial firms, which are permitted under Article 4 of the agreement, and in over a dozen instances have signed agreements or protocols with specific organizations.

In contrast with earlier cooperative agreements in science and technology, which emphasized basic scientific

research, the more recent Soviet interests are directed more toward areas of technology where additional work could lead fairly quickly to improved products and stepped up productivity for the USSR. For example, joint US-USSR research on catalytic reactor modeling and joint work on the design and operation of thermal and hydroelectric power stations are likely to benefit the USSR within a shorter period than the more scholarly work in pure mathematics or theoretical physics carried out under prior agreements. With some exceptions, the Soviets have had a long standing interest in these newer areas but their progress has been slow. Interestingly, in most of the areas -- including MHD, S&T information processing, and metrology and standardization -- at least one proposed project involves the use of computers, which is in consonance with other indications of intense Soviet interest in Western computer technology and applications.

Judging by the vigor of these efforts, it is clear that they have been strongly endorsed by the top leadership of the USSR. The Soviet scientists identified to pursue the collaborative research are among the USSR's best, and they seem to have received somewhat more freedom than in the past to plan and carry out viable cooperative programs.

Despite the Soviet desire for successful S&T cooperation with the US, the agreements have encountered delays. In

some cases, the Soviets are not yet ready to receive, fund, and otherwise take care of the US researchers who would be working in the USSR. Hard currency problems continually reappear with respect to Soviets traveling abroad, and communications between US scientists and their Soviet counterparts, particularly by letter, are very slow. Vestiges of the USSR's long history of secrecy in science and technology are still visible from time to time, but an unmistakeable loosening of sorts is evident.

To date, the USSR's recent overtures to US industry under Article 4 of the S&T agreement have been decidedly one-sided in that US companies in the end have given information to Soviet agencies not in return for other information but rather in the hope of getting a foothold in Soviet markets. With very few exceptions, the Soviets have refrained from revealing any technology of their own for possible licensing or trade with the US firms. However, there is some feeling on the part of the US firms that there probably is not much Soviet technology that would interest them. So far in these contacts, the Soviets have exhibited a preference for high technology and for dealing with large firms -- conglomerates and multi-nationals. It appears that the USSR's principal objective is to explore and possibly exploit without charge modern US technology under the guise of "cooperation," just as they have done with the French under the Soviet-French cooperation agreement.

Sharing the Burden with Bloc Countries

Eastern Europe's laboratories and industry have been an important source of technology for the USSR in the past. Through CEMA, the Soviets are trying to arrange a more systematic allocation of research responsibilities. The RYAD computer program is a notable example. In the late 1960s, Bulgaria, Czechoslovakia, East Germany, Hungary, and Poland reluctantly agreed to cooperate with the USSR in the joint development and production of RYAD computers. These countries already had their own computer projects as well as licenses to produce Western-style computers that were not compatible with RYAD. Eastern Europe was first given responsibility for developing software and peripheral equipment. Later, its role was exapnded to include central processing units as well. In the nuclear field, the USSR and East Europe have cooperated for a number of years in the production and distribution of radio isotopes for medical research and industry. The program was expanded in 1970 to include reactor engineering.

Meanwhile, the USSR expects to benefit from growing East European acquisition of Western technology, especially in the field of electronics. There are enough reported cases of such transfers to suggest that the Soviet Union normally gets the benefit of East European purchases of

Western equipment, sometimes including the equipment itself. A good deal of state-of-the-art as well as obsolecent technology has been transferred within the CEMA area in connection with the large and rapidly growing trade in machinery, the sale of licenses, and the recent spurt in joint Soviet-East European investment projects.

Release of Military R&D Resources

Although the resources presently preempted by Soviet military and space R&D programs would be of great use in the development of civilian technology or in assimilating Western technology, there is no evidence that the USSR is moving in this direction. In fact, the current pace of development of Soviet military weapons systems is such that barring abrupt cancellations of major programs, all major military R&D sectors -- including those concerned with ballistic missiles, major surface ships, manned bomber aircraft, space systems, and nuclear and conventional warfare weapons -- should be committed at least through 1975. After that time, the effects of international SAL negotiations may lead to some realignment in the allocation of R&D resources between military and civilian uses.

IV. Outlook

The Soviet campaign to acquire foreign technology has been and will be successful in a limited sense. The growing imports of machinery and equipment together with more cooperative ventures and bilateral agreements will transfer a substantial amount of Western technology to the USSR -- whether in the form of informal (and sometimes inadvertent) disclosure of know-how, exchanges of technical data, or finished products. Nevertheless, these transfers are unlikely to close the technological gap with the West or to speed Soviet economic growth appreciably. On balance the Soviet leadership probably will be disappointed in what is accomplished through machinery imports from the West, and the prospects for rapidly and effectively exploiting the other channels of technology transfer appear not much better.

- The direct effect of machinery imports will not be large because their volume will be small relative to total domestic investment in the USSR. In 1972, total imports of machinery and equipment from the Developed West were $1.4 billion. In view of the Soviet Union's hard currency constraint, machinery imports are not likely to exceed $4 billion to $5 billion by 1982. Assuming that these imports grow evenly over the 10 years, the increment could raise the growth of fixed investment in, for example, industry, agriculture, transportation, and communications by only 2/10 of one percent per year.

Although the imported technology should be more productive than the technology available domestically, it clearly cannot have much of an impact unless it can be duplicated and adapted on a wide scale. There is no indication that the Soviet record with respect to assimilating foreign technology will improve markedly in the short or medium term. Many of the difficulties in encouraging innovation are rooted in the unwieldy structure of the civilian R&D sector and in the lack of strong incentives for innovation in the Soviet economy. To the degree that the USSR concentrates on assimilating Western technology rather than developing its own, Western technology will tend to retain its position of superiority. Reliance on Western technology, therefore, would condemn the USSR to continuing technological inferiority and a corresponding position of disadvantage in international trade in manufactures.

The cooperative ventures now being considered have an importance beyond the quantity of technology transferred, however. Without Western (and particularly US) help, the Soviet Union could not develop its raw material resources as quickly as it hopes to. In part, the USSR simply lacks critical elements of the technology needed to exploit its

raw materials. The US can supply, for example, the drilling and valve technology necessary for rapid exploitation of oil and gas deposits in the permafrost regions of Siberia or off Soviet shores. Although the USSR will sell part of this oil and gas to finance its machinery imports, there is some evidence that the projects designated for joint Soviet-Western development will be needed to avert a Soviet energy shortage by the end of the 1970s.

The bilateral scientific-technical agreements, if carried out on a sufficiently broad basis, could help the USSR where it needs help most -- by providing a spark to the civilian R&D sector. But it is too soon to assess the results of these agreements. Plans for cooperative projects seem to be progressing more slowly than the USSR probably hoped. Some joint projects -- principally those involved in basic research -- will result in a fairly equitable distribution of benefits between the US and the USS Most other projects will benefit the USSR more than its partners. In all cases the quality of Soviet R&D work should be enhanced by the close contacts required by the agreements. Still, delays in communication and both government and private reluctance to divulge information will be a continuing problem and in a few instances may well lead to the termination of projects.

In sum, the prospects are dim that technology transfer from the US to the USSR will have a substantial influence

on Soviet economic development because -- for all of the reasons discussed above -- the transfers will probably be too meager and too slow. The domestic R&D establishment itself must generate most of the productivity gains necessary to speed up economic growth and to narrow the technological gap separating the USSR from Western countries.

Nonetheless, in some cases Western technology could be instrumental in making Soviet products competitive in Western markets. Some of the possibilities are important from the standpoint of their potential importance in world trade.

- The Soviet Union is at the technological frontier in U-235 enrichment, and low electric power costs in Siberia probably give some of their enrichment plants a competitive advantage over Western plants. If the USSR develops or obtains additional gaseous diffusion technology, the Soviet advantage would tend to increase. In addition, Soviet nuclear power reactor technology is on a par with the West, although their designs suffer from a difference in safety philosophy. The Soviets will either have to adopt Western safety practices or convince the West of the validity of their approach before they will be able to sell many reactor plants in the West.

- Soviet commercial aircraft have been improving steadily in terms of world standards. At least two remaining technical hurdles must be overcome, however, before Soviet civilian

aircraft can be considered truly competitive in the world market: they must have (1) internationally approved navigation systems and (2) performance in terms of engine life and economy comparable to Western aircraft. They are well on their way to acquiring navigation systems by purchase of Western equipment and technology. Improving engine performance may take longer because the Soviet metallurgical industry generally has not been able to control quality adequately in the production of high temperature materials. However, acquisition of this technology from the West may be prohibited due to its direct military application.

- The Soviet manufacture of certain common biological products and pharmaceuticals -- aspirin, penicillin, streptomycin, and the like -- could be improved, with minimal technical help, to the level which would allow international competition with similar Western items. This same observation is applicable to many packaged edibles and potables.

The acquisition of some aspects of Western technology could have effects on Soviet productivity and competitiveness that cut across product lines or industrial boundaries. Two areas may be cited, both of which have been developed intensively in the West in the past decade or so. The first area includes the technology associated with all phases of industrial instrumentation, particularly for automation and

quality control processes. The second area comprises the sophisticated methods and mechanisms for performing systems analysis of new, particularly large and complex technology and for calculating relative cost-effectiveness. Soviet exports are presently penalized by the lack of effective quality control in the manufacture of many products while reliable automated processes are the key to needed cost reductions in some producing sectors. Better planning of investment and operating decisions would, in turn, enhance production efficiency.

In these areas and possibly in many others, US firms will have to scrutinize individual sales and projects carefully to determine whether the potential indirect effects on US markets outweigh the gains from a direct sale of US technology for hard currency or raw materials.